



Socioeconomic inequalities in ageing and health

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Socioeconomic inequalities in health are complex and challenging problems. Although the poorer health and shorter life expectancies of people in lower socioeconomic groups than of those in more privileged classes are not surprising, elucidation of the reasons for these inequalities has proven difficult. Some researchers have focused on the role of unhealthy behaviours, others have emphasised the importance of psychosocial stress, and yet others have called attention to material problems such as diet, housing, and occupational exposure to toxins. We don't yet have a conceptual framework for integrating these disparate factors into a comprehensive understanding of health inequalities. I believe that evolutionary medicine can provide such a framework. Inequalities in health can be understood as resulting from differences in rates of ageing: people in lower socioeconomic classes appear to age more rapidly than do those in higher classes. An evolutionary view of ageing provides a valuable new perspective for analysing health inequalities and for considering interventions to reduce them.

Biologists think of ageing or senescence of individuals as a progressive, generalised decline in physiological function, resulting in an impairment of homeostatic mechanisms and an increasing probability of death, frequently accompanied by a decline in fertility. This definition may sound grim, but of course many older people lead healthy, productive, and satisfying lives. Ageing of population cohorts is manifested as increases in age-specific morbidity and mortality rates. Investigators

in the Whitehall II study of British civil servants asked participants between the ages of 50 and 74 years to describe and rate their health. Respondents reported progressive deterioration of their physical health over this period; importantly, people in lower employment grades reported earlier and more rapid declines in health than did those in higher classes. Mortality data collected by the UK Office for National Statistics are consistent with these reports. The Office for National Statistics has analysed mortality rates for men aged 25 to 64 years as a function of the national statistics socioeconomic classification. Mortality rates increased with age for men in all socioeconomic classes, but at all ages, age-specific mortality rates were higher for men in lower socioeconomic groups than for those in higher classifications. Whether measured in terms of morbidity or mortality, people in the lowest socioeconomic classes appear to age about 5 to 10 years earlier than do those in more privileged groups. How can we understand these differences? Here is where I think an evolutionary view of ageing can help.

People, like other living organisms, have finite resources of energy and time, and must allocate these resources among growth and development, reproduction, the tasks of daily living, and somatic or bodily maintenance or repair. The evolutionary theory of ageing is based on the idea of trade-offs between these competing demands; energy that is used for growth or reproduction is not available to be used for bodily repair. Natural selection shapes the allocation of resources between growth, reproduction, and bodily maintenance in ways that improve reproductive fitness. Rates of ageing are determined by the rates at which animals die of external causes such as starvation and predation: animals must reach sexual maturity and reproduce before these external causes can come into play. Species that have adaptations that reduce the risk of external causes of death can put more resources into bodily maintenance and can thus evolve longer life spans. The human life span is significantly longer than that of chimpanzees or gorillas; our long life span appears to have evolved in conjunction with our ability to work together in groups to hunt and to repel predators. Nonetheless, our longevity and health are merely by-products of selection for reproductive fitness. Our ancestors had to stay alive and healthy long enough to produce and raise children (and, perhaps, to help raise grandchildren), but what happened to them after that was of little evolutionary consequence. Natural selection has favoured the spread of traits that promote growth and reproduction at young ages, even if these traits make us susceptible to disease and death in later life. Tom Kirkwood has dubbed this theory the disposable soma theory of ageing. In today's idiom, we might call it the recyclable soma theory; our bodies get degraded and recycled while our germ cells are transmitted to our offspring.

Our bodies are constantly undergoing somatic damage: ions leak across cell membranes, DNA becomes damaged, proteins unfold, and cells die. In addition, we lose heat to the environment. Bodily damage is an inescapable by-product of living. Continued physiological function depends on the repair of this damage. Not

surprisingly, we have a wealth of biochemical mechanisms to prevent or reverse somatic damage; our antioxidant defences are one well-known example of these protective mechanisms. All of these processes require energy; our resting metabolic rates reflect the requirements of bodily maintenance and repair. Because resources are limited, and because natural selection has led to the allocation of energy to growth and reproduction in ways that enhance reproductive fitness rather than longevity, somatic maintenance is imperfect. Ageing is a consequence of the accumulation of unrepaired somatic damage, which leads to cell death, loss of organ system function, disease, and, ultimately, death.

During fetal life, we develop physiological reserves and regenerative capacities that can buffer the effects of later somatic damage. For example, we produce stem cells, which can replicate and differentiate later in life to replace dead or dying cells. Production of these reserve capacities also requires energy; natural selection has presumably adjusted the magnitude of these capacities in concert with our other energy needs. Rates of ageing are determined by the relations between the developmental processes that create reserve capacities and the cumulative bodily damage (the excess of injury over repair) that depletes them, and so are influenced by the genes and environmental factors that modulate these processes.

An economic metaphor might help to illuminate this evolutionary view of ageing. Developmental processes produce what my colleague Robert Fogel has called physiological capital. Bodily damage engenders physiological costs that are greater than the portion of our energy budget we can allocate to maintenance and repair processes; we draw on our physiological capital to maintain health despite this continuing deficit in our current account. Natural selection has endowed us with sufficient physiological capital to stay alive and reproduce successfully in the face of expected demands for this capital; eventually, however, depletion of the capital leads to physiological bankruptcy, or death. Our evolved mechanisms for the production and depletion of physiological capital discount the value of future health and well-being; natural selection sets the discount rate.

Given an evolutionary view that highlights the importance of physiological reserves, of somatic damage, and of biological repair mechanisms in determining rates of ageing, how should we think about health inequalities? Socioeconomic inequalities in all of these factors are likely to contribute to inequalities in rates of ageing. In economic terms, disadvantaged people are born with lower physiological capital and deplete this capital at greater rates than do more privileged people; socioeconomic disadvantage leads to a higher discount rate for the value of longevity and health.

Babies born into families in lower social classes have an increased risk of prematurity and low birthweight. Since the period of fetal development is an especially important time for the accumulation of physiological reserves, these babies are likely to begin life with lower reserves. Inequalities in fetal development, whether caused by maternal smoking, poor nutrition, or other factors, might lead to



inequalities in physiological reserves, which in turn can lead to inequalities in health—including inequalities in hypertension, stroke, and coronary heart disease. Various environmental toxins cause somatic injury. Rates of bodily injury are influenced by behavioural (eg, smoking), residential (lead), and occupational (coal mine dust) exposure to toxins, as well as by the dietary intake of micronutrients (vitamins and minerals) that contribute to our antioxidant defences. Socioeconomic gradients in all of these factors could lead to gradients in rates of somatic injury, and thus contribute to inequalities in rates of ageing.

The activities of somatic repair processes are difficult to quantify. Nonetheless, there are good reasons to believe that there are socioeconomic inequalities in the activity of these repair processes. Gradients in psychosocial stress seem to have a major role in health inequalities. Fear of physical violence, lack of autonomy, lack of access to resources, and social isolation can all contribute to disease-causing psychosocial stress. Although the neuroendocrine responses to psychosocial stress are not fully understood, they involve increased secretion of the stress hormones cortisol and epinephrine, as well as other hormones, neurotransmitters, and cytokines. Stress hormones diminish the activity of somatic repair mechanisms—they divert energy from somatic repair to meet more immediate and pressing needs—and thus may contribute to the pathway by which psychosocial stresses lead to accelerated rates of ageing.

Poor or disadvantaged people may engage in risky or unhealthy behaviours to a greater extent than more privileged people do, but these behaviours themselves may be part of our evolved response to social inequality. We have evolved psychological mechanisms to assess our social environment and to adjust our behaviour in response to this assessment. The psychosocial stress of poverty or social disadvantage appears to predispose people to behave in ways that privilege immediate over long-term rewards—in other words, to discount the value of their future health. These psychological mechanisms complement and reinforce the physiological processes that produce health inequalities.

Some of the major causes of inequalities in age-specific mortality rates, including ischaemic heart disease, lung cancer, and cerebrovascular disease, are diseases of ageing. To understand health inequalities as disparities in rates of ageing, and therefore as resulting from disparities in the development and depletion of physiological capital, provides a biological framework for analysis of these inequalities. Not all health inequalities result from inequalities in rates of ageing, however. Inequalities in accidents, injuries, and suicides are greatest in young adult life or middle age. Moreover, there are inequalities in perinatal and neonatal mortality. I believe that the evolutionary view of ageing I have outlined can also help us understand these other inequalities. Factors that reduce the accumulation of physiological reserves during fetal development could increase perinatal and neonatal mortality as well as susceptibility to disease in adult life; environments that increase

rates of somatic damage might also increase rates of accidents and injuries; and psychosocial stresses can lead to suicide as well as to disease. An evolutionary perspective provides a way of thinking about the many interacting behavioural, psychosocial, and material factors that affect vulnerability to disease for all people but that differentially affect the health and well-being of people in lower socioeconomic classes.

Inequalities in health are moral as well as medical problems; they exemplify what Paul Farmer and others have called the structural violence of hierarchical societies. Although we still have much to learn about the details of the causal pathways that lead to inequalities in health, these gaps in our knowledge need not and should not keep us from acting to reduce these inequalities. Improved access to health care, better health education, and the provision of preventive health services are all to the good, but we shouldn't expect these interventions by themselves to reduce health disparities. After all, inequalities in health have persisted despite the public health and medical advances that have led to great increases in life expectancy over the last century.

Health inequalities are closely tied to economic inequalities. Unfortunately, governments have generally pursued economic policies without consideration of their health consequences. Over the past few decades, socioeconomic inequalities in many developed countries have been increasing. Recent evidence suggests that health inequalities in the USA are also beginning to increase. If we are serious about reducing health inequalities, we need to consider the health consequences of economic policies and include the cost of health inequalities in the analysis and evaluation of these policies. Let's hope that an evolutionary understanding will help to stimulate the implementation of programmes that reduce socioeconomic inequalities in health.

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Further reading

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